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# FAILURE OF AN INSECT ELECTROCUTING DEVICE TO REDUCE MOSQUITO BITING[1]

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ABSTRACT. Insect electrocuting devices using ultraviolet light as an attractant were tested for their ability to reduce mosquito biting in backyards. Biting collections were made in 6 adjacent backyards located in South Bend, Indiana. Two of the yards were equipped with electronic insect killing devices, 2 with CDC traps, and 2 had no apparatus. The collections were made on 8 nights from June through August 1982. The insects killed by the electrocuting devices also were collected. Only 3.3% of the 3212 insects killed on an average night were female mosquitoes. Humans in the vicinity of the electrocuting devices were consistently more attractive to mosquitoes than the devices. Even after 11 days of continuous operation, the electrocuting devices failed to reduce the mosquito biting rate.

## INTRODUCTION

Electronic insect killing devices using an electrocuting grid and ultraviolet (UV) light as an attractant (commonly sold as Zappers,™, Bugwackers,™, Bug Blasters,™ etc.) frequently are used in an attempt to control pest insects in backyards, campgrounds, swimming pools and other outdoor recreation areas. These devices are advertised on the basis of claims by the manufacturers that they have a "lure range" of a certain distance depending on the power of the UV source, they can clear insects from a certain radius around the trap, and they disrupt the "breeding cycle" of insects. Test data available from some of the manufacturers indicate that, if they are the sole source of light, these devices are useful in reducing indoor house fly populations. Unfortunately, no data are presented on the efficiency of these traps outdoors or their ability to reduce mosquito biting; the purpose for which most of the traps are purchased. This study was designed to evaluate the ability of these devices to reduce mosquito biting in backyard situations.

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## MATERIALS AND METHODS

The study was conducted from late June through August 1982 in a suburban neighborhood on the northeast side of South Bend (St. Joseph County), Indiana. The area was known to have moderate to heavy local populations of *Aedes vexans* (Meigen) and *Ae. trivittatus* (Coquillett) (St. Joseph County Mosquito Abatement Program, Unpublished data). The testing was conducted in 6 backyards within the neighborhood. The backyards were adjacent to each other in a straight north to south line. Each backyard was approximately 35 m square. The 6 yards were surrounded on the north, south, and east by similar residential areas. Adjacent to the yards to the west was a small, shallow drainage ditch (ca. 1 m wide) frequently containing water and intermittently producing *Ae. trivittatus*. Immediately to the west of the drainage ditch was a 5 to 15 m wide woodlot running almost the entire length of the backyards. The woodlot consisted of large, mixed deciduous trees (trunk diam. 10–40 cm) and a dense herbaceous understory. To the west and south of the woodlot was a schoolyard consisting of mowed grass. Immediately to the north of the woodlot was an unmowed field with vegetation ranging from 0.5 to 2 m high. The landscaping in the individual yards varied from completely open mowed grass to yards containing ornamental shrubs, ground cover and small vegetable gardens, to wooded yards with large deciduous trees (trunk diam. 30–60 cm) and a relatively complete canopy.

The electrocuting device chosen for the study was the Sears model 833.1432 Electronic Insect Killer.[2] This device consists of a 25 watt UV bulb surrounded by an electrocuting grid inside a protective screen and rain shield, and is similar to the design of most electronic insect killers. It is advertised as having a "lure range of 279 $m^2$ (3200 $ft^2$, ca. ¾ acre) and as being effective over a radius of 30.5 m (100′) from the trap. The operating instructions recommend that the devices be placed "25–50 ft away from the area of human activity and nearby insect infestation to draw insects away."

In the first series of tests, yards were chosen at random and 2 yards were equipped with the electrocuting devices, 2 yards were equipped with standard 6 volt CDC traps, and 2 yards contained no device. The electrocuting devices were suspended 2.5 m above the ground in the center of the yards and were turned on 36 hr prior to the collection of biting mosquitoes. Mosquitoes coming to human bait were collected in each yard from 1 hr before to 1 hr after sunset on 6 nights of mild weather (wind 0–8 km/h. RH 75–95%, temp. 15–24°C). The 2 hr experimental period was divided into six 15 min collecting periods with 5 min between periods. The individuals serving as bait were stationed 8 m east of the electrocuting devices and CDC traps (on the opposite side of devices from the wooded area) and in a similar position in the yards with no apparatus. The collectors captured mosquitoes coming to bite during the 15 min periods with a mouth aspirator. After each 15 min period, the collectors moved to different yards to adjust for individual variation in attractiveness to mosquitoes and collection efficiency. The possible effects of landscaping and trap placement in the yards were controlled by moving the traps to different yards during each night of testing. As a result, each yard was tested with the electrocuting device, CDC trap or no apparatus twice during the experiments.

The biting rate in each yard was determined by totalling the number of mosquitoes collected coming to bite during the six 15 min periods and expressing that number as a percent of the total collected in the yard with the maximum number for the night. Expressing the biting rate as a percent of the maximum allows comparison of results between nights despite variations in the absolute number collected due to climatic and other factors.

The number of insects killed by an electrocuting device was determined by collecting the insects in a fine mesh nylon net bag attached to the bottom of the device. Collections of this type were made during the 2 hr test periods on 5 of the 6 nights of testing. In addition, the insects killed by the electrocuting devices were collected during 5 daylight periods (0700–1900 h) and five 24 hr periods to determine what proportion of the insects were killed during the daylight hours, how many and what kind of insects other than mosquitoes were killed, and the proportion of mosquitoes to non-mosquitoes killed.

A second series of tests was performed to determine if long-term use of the electrocuting devices (as recommended by the manufacturer) reduced mosquito biting. An electrocuting device was suspended in the center of 2 of the yards (chosen at random) and run 24 hr daily for 10 and 11 days prior to conducting 2 nights of human bait collections in the manner described above. Statistical analysis of data used the methods described in Sokal and Rohlf (1969).

## RESULTS

The electrocuting devices killed an average of 3212 insects per 24 hr period during the 5 collections that were made (Table 1). Of these, the vast majority (89%) were small non-mosquito nematocerous Diptera. Several other types of insects were found in the collections, including mosquitoes which comprised 6.4% of the total kill. Approximately half of the mosquitoes killed were female and constituted only 3.3% of the total insects killed.

An average of 66 insects were killed during each of the 6 daylight periods sampled (Table 1). Non-mosquito Nematocera were the most frequently killed insects (36%) followed closely by muscoid flies (33%). An average of less than 2 mosquitoes were killed per period, constituting 2.7% of the daytime kill.

During the 2 hr samples taken during the twilight periods when the biting collections were made, an average of 2163 insects were killed by the electrocuting devices (Table 1). Non-mosquito Nematocera were the most frequently killed insects (88%). Mosquitoes comprised 4.3% of the total insects killed with females making up slightly more than half of this number. CDC traps, because of their low pow-

[2] Sears Roebuck and Company, Chicago, IL 60684. Mention of trade names is for identification only and does not constitute endorsement by NIH or the University of Notre Dame.

Table 1. Average number and percentage of the total number of insects killed by electrocuting devices during 24 hr periods (n=5), daylight periods from 0700 hr to 1900 hr (n=6), and the 2 hr test periods (n=10).

| | Average number of insects killed | | |
|---|---|---|---|
| | 24 hr period | Daylight period | 2 hr test period |
| Coleoptera | 68.8 (2.1)* | 6.3 (8.1) | 79.0 (3.7) |
| Lepidoptera | 37.2 (1.2) | 0.6 (0.9) | 1.5 (<.1) |
| Hemiptera | 9.2 (0.3) | 1.2 (1.8) | 20.4 (0.9) |
| Homoptera | 2.4 (<.1) | 1.2 (1.8) | 0.9 (<.1) |
| Ephemeroptera | — | — | 0.2 (<.1) |
| Trichoptera | 41.2 (1.3) | 1.0 (1.5) | 41.0 (1.9) |
| Hymenoptera | 1.8 (<.1) | 3.2 (4.9) | 2.4 (0.1) |
| Muscoid flies | 43.2 (4.5) | 21.3 (32.5) | 9.6 (0.4) |
| Empididae | 11.8 (0.4) | 0.3 (0.5) | 11.2 (0.5) |
| Non-mosquito Nematocera | 2863.2 (89.1) | 23.7 (36.2) | 1905.9 (88.1) |
| ♀ mosquitoes | 106.8 (3.3) | 1.0 (1.5) | 49.0 (2.3) |
| ♂ mosquitoes | 100.6 (3.1) | 0.8 (1.2) | 42.3 (2.0) |
| Total insects | 3211.8 | 65.6 | 2163.4 |

* Percent of total number of insects killed.

ered light source, collected very few insects during the twilight test periods.

During the first series of tests, in which the electrocuting devices were turned on 36 hr prior to making the biting collections, 1143 mosquitoes were collected coming to bite in the yards equipped with the electrocuting devices, 1096 in the yards with the CDC traps, and 1110 in the yards with no apparatus. There was no difference in the biting rate experienced in the yards with the electrocuting devices, with CDC traps, and with no apparatus (ANOVA $P > .05$, Table 2). The biting rates in the yards with electrocuting devices ranged from 31% to 100% of the maximum. The yards with CDC traps ranged from 44% to 100% of the maximum, and the yards with no apparatus ranged from 40% to 100% of the maximum.

In the yards equipped with the electrocuting devices, 1089 female mosquitoes were collected from the human bait and 489 were killed by the electrocuting devices (Table 3). The majority of those collected coming to bite were *Ae. trivittatus* while *Ae. vexans* was the species most frequently killed in the electrocuting devices.

When the number of mosquitoes coming to bite in the yards equipped with the electrocuting devices is compared to the number killed in the electrocuting devices on an individual basis, the number coming to bite exceeded the number killed by the electrocuting devices in every case (Table 4).

The second series of tests, in which the electrocuting devices were run continuously for 10–11 days prior to making biting collections, produced results similar to those of the previ-

Table 2. Mosquito biting rate experienced in yards equipped with electrocuting devices, CDC traps, and no apparatus. The rate in each yard is a percent of the number collected in the yard with the highest total for the night. The traps were moved to different yards for each trial and were turned on 36 hr prior to testing in test 1. In test 2, the traps were left in the same yards and run 10-11 days prior to testing.

| | Percent of maximum biting rates | | | | | | |
|---|---|---|---|---|---|---|---|
| Trial | Electrocuting device | | CDC trap | | No apparatus | | Maximum #@ |
| Test 1* | 1 | 2 | 1 | 2 | 1 | 2 | |
| 1 | 66 | 57 | 100 | 75 | 75 | 84 | 44 |
| 2 | 57 | 31 | 50 | 77 | 100 | 74 | 68 |
| 3 | 87 | 97 | 58 | 100 | 40 | 94 | 62 |
| 4 | 89 | 100 | 62 | 82 | 87 | 55 | 219 |
| 5 | 85 | 100 | 88 | 86 | 91 | 63 | 172 |
| 6 | 61 | 58 | 100 | 44 | 83 | 87 | 154 |
| Test 2** | | | | | | | |
| 1 | 68 | 86 | 100 | 79 | 51 | 49 | 85 |
| 2 | 46 | 100 | 38 | 66 | 47 | 31 | 55 |

* No difference in biting rate between areas with electrocuting devices, CDC traps, and no apparatus (ANOVA $P>.05$).

** No difference in biting rate between areas (Kruskal-Wallis Ranks Test $P>.05$).

@ Maximum is the highest number of mosquitoes collected coming to bite in a yard during the test period.

Table 3. Number of mosquitoes collected coming to bite in a backyard with an electrocuting device and the number killed in the device. Total of ten 2 hr test periods.

| Species | Number killed or collected | |
|---|---|---|
| | Electrocuting device | Human bite |
| *Ae. vexans* ♀ | 174 | 211 |
| *Ae. vexans* ♂ | 126 | — |
| *Ae. trivittatus* ♀ | 11 | 738 |
| *Ae. trivittatus* ♂ | — | — |
| Other species ♀* | 304 | 140 |
| Other species ♂* | 297 | — |
| Total mosquitoes | 489 | 1089 |

* Including unidentified specimens.

ous tests. A total of 211 mosquitoes was collected coming to bite in the yards with the electrocuting devices, 209 in the yards with the CDC traps, and 128 in the yards with no apparatus. The biting rate did not differ in yards with electrocuting devices, CDC traps, or no apparatus (Kruskal-Wallis Ranks Test $P > .05$, Table 2).

Marked differences were detected, however, in the number of mosquitoes collected by the individuals serving as bait. Of the 10 persons volunteering their services throughout the study, the average collection rates ranged from a low of 0.4 mosquitoes/min to 1.29 mosquitoes/min. Although only marginally significant (ANOVA $P = .09$, Kruskal-Wallis Test $P \leq .05$) there was a noticeable trend in the biting rates experienced in the different yards, regardless of the presence or absence of electrocuting devices. Though somewhat variable, the biting rate in certain yards was consistently higher than the rate detected in other yards, even though they were adjacent to each other.

## DISCUSSION

Although many insects were killed by the electrocuting devices used in this study, the devices did not reduce the number of mosquitoes coming to bite. This was true even after the recommended long term use of the traps. These results are consistent with previous evaluations of other similar devices (Surgeoner and Helson 1977; G. B. Craig, Jr., personal communication).

Several factors are responsible for the failure of these devices to reduce mosquito biting. The primary factor is that humans are more attractive to mosquitoes than UV light. This is evident in that, given the same amount of time, the human bait in yards equipped with electrocuting devices collected 1089 female mosquitoes while the electrocuting devices killed only 489 (Table 3). Related to the fact that the electrocuting devices kill few mosquitoes, is the problem that an attempt to control populations of organisms possessing the reproductive potential and dispersal capacity of mosquitoes by killing a few hundred a night, even on a very local basis, is a futile effort at best.

Another major shortcoming of these devices is that not all insects, including mosquitoes, are equally attracted to light. Insects active during the daytime or early evening periods will not be influenced by the presence of the UV light. *Aedes trivittatus* was such a species in this study, rarely occurring in the electrocuting device collections from the evenings and never from the daylight samples. In addition, the total number of insects killed in the daylight samples was only 2% of the number killed during the total 24 hr period.

In summary, the electrocuting devices were not successful in reducing mosquito biting and most of the insects killed were innocuous to humans. It seems probable that mosquito biting in backyards could be influenced more by using personal repellents, changing the type of clothing or soaps used by persons in the area, or by altering the landscaping of the area to remove mosquito resting habitats (shrubbery, heavy ground cover, etc.) from the immediate vicinity, than by the use of UV light attractant electrocuting devices.

Table 4. Number of female mosquitoes collected coming to bite in a yard with an electrocuting device, and the number killed in the device during 5 individual 2 hr tests.

| Trial | Number of female mosquitoes captured | | | |
|---|---|---|---|---|
| | Site 1 | | Site 2 | |
| | Electrocuting device | Human bait | Electrocuting device | Human bait |
| 1 | 31 | 94 | 49 | 90 |
| 2 | 44 | 146 | 151 | 172 |
| 3 | 129 | 194 | 30 | 219 |
| 4 | 15 | 54 | 12 | 60 |
| 5 | 11 | 39 | 17 | 21 |
| Total | 230 | 527 | 259 | 562 |

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# VECTOR-COMPETENCE STUDIES FOR BLUETONGUE AND EPIZOOTIC HEMORRHAGIC DISEASE VIRUSES WITH *CULICOIDES VENUSTUS* (CERATOPOGONIDAE)

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ABSTRACT. Field-collected females of *Culicoides venustus* from New York state were tested for oral susceptibility to bluetongue (BT) and epizootic hemorrhagic disease (EHD) viruses. The infection rates obtained for females exposed to a virus meal were low (BTV 0.7% for 1/141, EHDV 2.6% for 1/38), suggesting that the species would not be an efficient vector of these viruses in New York. Females of *C. venustus* were easy to use in vector competence studies with the same methods used for *C. variipennis;* they were relatively long-lived and readily fed through a membrane and on embryonating chicken eggs. Three other species of *Culicoides* did not take a blood meal under the same conditions except for a few females of *C. stellifer* that were long-lived and assayed negative for infection with BTV.

Several species of *Culicoides* are pests of mammalian livestock in New York State (Schmidtmann et al. 1980). Four of these species, *C. venustus* Hoffman, *C. stellifer* (Coquillett), *C. biguttatus* (Coquillett) and *C. obsoletus* (Meigen), were used in experiments to determine if they could be vectors of bluetongue virus (BTV) or of epizootic hemorrhagic disease virus (EHDV). Of these, only *C. venustus,* a relatively large and robust species, was used successfully in that sufficient numbers of females took blood meals. This species is widespread in the eastern United States with its range extending westward to Wisconsin and southward to Florida (Wirth 1965).

This paper reports preliminary laboratory studies to determine whether *Culicoides* species other than *C. variipennis* (Coquillett), the primary vector of BTV throughout most of the United States (Jones et al. 1981), are potential vectors of BTV. Because the methodology for the use of a species is important, we used several test procedures to determine whether field-collected females of *C. venustus* would be easy to use in arbovirus research.

## MATERIALS AND METHODS

Adult *Culicoides* were collected in 1978–79 from a pasture in Tompkins County, New York with light traps baited with $CO_2$ (dry ice). A serologic survey for antibody to BTV in slaughter cattle had indicated that BT was rare or nonexistent in New York State (Metcalf et al. 1981), and BTV or EHDV have never been reported from the collection area.

Female flies were separated to species, shipped alive lightly chilled, and used in experiments under the same conditions used with *C. variipennis* (Jones and Foster 1978a). They were offered an infective blood meal (1 part cell-culture-adapted virus suspension and 9 parts defibrinated sheep blood) through membranes prepared from the skins of 1-day-old chicks. The blood meal contained about $10^{7.5}$ median cell-culture infectious doses/ml. En-

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